From the Atom to the Grain of Sand: Ascending the Stoppardian Ladder

Research Thesis

Presented in partial fulfillment of the requirements for graduation

with research distinction in English

in the undergraduate colleges of The Ohio State University

by

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April 2017

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Acknowledgments

I am extremely grateful to my advisor Prof. Sebastian Knowles for his nuggets of insight over the past year, and for teaching me with an irrepressible energy and a Joycean perspective for the past three. Prof. Jacob Risinger is responsible for introducing me to *Arcadia* and effectively sending me down the Stoppardian rabbit-hole. Many thanks to him for being more than cursorily involved in the writing process as my second reader. I also cannot emphasize the role that my family and friends played in providing moral support, and in helping me understand aspects of science and finance that lay beyond my expertise.

INTRODUCTION

An attempt to summarize Tom Stoppard in a nutshell is an exercise in futility and must be abandoned at once. In the forty years since *Rosencrantz and Guildenstern Are Dead* catapulted him into becoming an overnight success,[1] Stoppard's style has been characterized as being absurdist, postmodernist, emotionally distant, philosophical, political, intellectual, and undoubtedly described with a few more adjectives. Every time a new label gets slapped onto one of his works, Stoppard has the tendency to wiggle out of the characterization by churning out a new, genre-defying piece, and it seems to me that the only commonality within his works is that they all display elements of Stoppardianism.[2]

Most of Stoppard's plays feature moments of immense theatricality, and his mastery exists in creating visuals that baffle and enrapture his audience.[3] He is very cognizant of the magic that can be created without words, and in a lecture titled "The Event and the Text," he provides an anecdote of an amateur production in Cambridge which he personally never got a chance to see:

> This production of *The Tempest* took place in the open air in the early evening, and when it became time for Ariel to leave the action of the play he turned and ran up the stage, away from the audience. Now the stage was a lawn, and the lawn backed on to a lake. He ran across the grass and got to the edge of the lake, and he just kept running, because the director had had the foresight to put a plank walkway just underneath the surface of the water. So you

[1] Stoppard had in fact been a struggling writer, and termed himself "mainly self-unemployed" for seven years before his career took off in 1967 (Fleming, *Finding Order Amidst Chaos*, 13).
[2] Term coined by William Demastes in *The Cambridge Introduction to Tom Stoppard* (3).
[3] The opening scene of *Jumpers* dazzles its audience with a trapeze swinger doing a strip-tease, while acrobats and gymnasts form a human pyramid. *After Magritte* is famous for the curtain ascending to a stage full of characters in seemingly absurd poses, although it is later revealed that there is a perfectly logical explanation for them.

> have to imagine: it's become dusk, and quite a lot of the artificial lighting has come on, and back there in the gloom is the lake. And Ariel says his last words and he turns and he runs and gets to the water and he runs and goes splish splash, splish splash, right across the lake and into the enfolding dark, until one can only just hear his footsteps making these little splashes and then ultimately his little figure disappeared from you … This is the thing, you can't write anything as good as that. If you look it up, it says 'Exit, Ariel'
>
> (Delaney, 200)

Influenced by the effect produced by the lights and walkway, Stoppard puts a great deal of thought and effort into the staging of his plays. Evidence of this can be seen in his painstaking placement of relatively irrelevant props (say a bucket that Hilary throws up into in *The Hard Problem*) in a position which maximizes the comic effect of a scene.[4]

A firm believer of the literary tactic of constructing "lines, characters and whole plots [to] reappear all the time to remind us that evolution is a matter of reproduction," Stoppard recycles old texts in many of his works (Fleming, "Tom Stoppard: A Portrait of the Artist as a Young Man," 40).[5] He presents his audience with "familiar literary language made strange by an unfamiliar dramatic context," thus inviting them to appraise a situation from a perspective different from an inherently myopic one (Kelly, "Introduction: Tom Stoppard in Transformation," 10). Oftentimes, he works in the opposite direction, presenting a bizarre situation which on further explication has a perfectly rational conception.[6] Referring to *Jumpers*, Stoppard recounts how "we see a man carrying a tortoise in one hand, and a bow and arrow in

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[4] Stoppard mentions that "the joke didn't land" until the bucket – a reference to the threat of projectile vomiting in a previous scene – was placed on the bed right between Spike and Hilary.
[5] *Rosencrantz and Guildenstern Are Dead* uses entire scenes from Shakespeare's *Hamlet*, while *Travesties* features excerpts from Joyce's *Ulysses* and *Finnegans Wake*, as well as Oscar Wilde's *The Importance of Being Earnest.*
[6] See footnote #3.

the other, his face covered in shaving foam. A trick I enjoy very much is when, bit by bit, you build up something ludicrous – and then someone walks in" (Gussow, *Conversations,* 7-8). Employed to a subtler extent in *Hapgood,* the appearance of Celia Newton (Elizabeth's twin) is a disconcerting moment for the audience, but as will be discussed later, it serves the purpose of driving home the point of the play. Not only does this add to theatricality but it also serves to embody one of Stoppard's main preoccupations, that of rationality commingled with unconventional ideation, all seeking to somehow understand human existence.

After experimenting with several mediums, Stoppard concluded that he preferred writing dialogue, saying that "the whole point of writing plays is that you can't contradict yourself in public without becoming less than respectable" (Delaney, 36). This trope is visible in a lot of the witty dialectics in his plays where he extends an argument as far as possible without committing to either side, then transforms the situation with a convenient interruption so that the discourse is left on a caesura,[7] Stoppard makes use of this technique for precisely the reason that he doesn't want to commit to a specific school of thought, and to him, uncertainty rather than definitiveness is a virtue.

Along with his tool for self-contradiction is Stoppard's uncanny precision with words, which leads the audience down a rabbit hole of puns and misconstruction of meaning. Manipulated to its maximum degree in *Arcadia,* this method not only lends some of its characters a distinctly Wildean flavor, but leads to a "way of argument and rebuttal, [revealing] that language both is and is not up to the tasks it is generally intended to perform" (Demastes, 28).

[7] Examples are visible in *The Hard Problem*, which will be examined later, as well as in *Travesties* between Joyce and Tzara.

Given that Stoppard explores topics ranging from the existential ramblings of two minor characters from *Hamlet,* to playwrights experiencing love and loss, to nineteenth-century Russian intelligentsia, any discussion of his works necessitates choosing a subset that involves a common theme. This paper will target plays that deal primarily with scientific principles, and although some of Stoppard's earlier works hint at issues like probability, biology, and the concept of infinity, I focus on three plays that hinge upon scientific discoveries made over the past century.

For a writer of fiction, a story is the outcome of imagination; for a scientist, a conclusion is the outcome of a conjecture. The two processes are similar in the sense that they both involve some degree of speculation. Stoppard is the quintessential imaginative artist who married his artistic vision with the precision of a scientist. He is known to manipulate a familiar situation by introducing an element of speculation, and then indulging in a dialectic that tickles the intellect but remains unresolved. Imagine a die, except instead of numbers it has the following scientific concepts scrawled on its sides:

- ⚀ Genetic Determinism
- ⚁ Chaos Theory
- ⚂ Quantum Mechanics,
- ⚃ Gödel's Incompleteness Theorem,
- ⚄ Positional Geometry
- ⚅ Thermodynamics.

Now imagine Stoppard sitting at a desk, rolling the die exactly twice, and then formulating a play based on those two motifs, somehow connecting it to reality and emphasizing the meaningfulness of life. *Arcadia* (1993), *Hapgood* (1988), and *The Hard Problem* (2015) are the

product of this little exercise, except that Stoppard has been rolling the die around in his head since before *Rosencrantz and Guildenstern are Dead* even got staged![8]

Referring to the reception of Stoppard's scientifically-oriented plays, John Fleming claims that "critics find the sheer amount of intellectual material one must know (or absorb) in order to fully appreciate a Stoppard play to be off-putting" (Fleming, "Tom Stoppard's Arcadia," 24). However, Clive James, a reluctant theater-goer, looks at the dynamism of Stoppard's plays, and analyzes Stoppard from the perspective of relativity, arguing his style is analogous in the sense that it eliminates the possibility of a viewpoint at rest. "Here and now in Stoppard is a time and place defined by an infinite number of converging vectors each heading towards it at the speed of light and steadily slowing down to nothing before passing through it and speeding up again," and used in the context of Zeno's paradox that Stoppard stages in Jumpers,[9] he mentions that "there is a fear in it – the awe of watching a slow approach down long perspectives" (73). The here and now in Stoppard's plays *is* relative: sometimes represented through the failing memory of a senile amnesiac, while at other times the here is held fixed in space while the now oscillates between centuries.[10] The reason why this reading on Stoppardianism is relevant is because James ends the essay by saying that "it might be only in Stoppard's enchanted playground that the magical inevitability of General Relativity can be reconciled with the Uncertainty Principle or quantum physics," and the three scientific plays together work towards that very reconciliation (76).

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[8] Summarizing a point in *Lord Malquist and Mr. Moon* (1966), Clive James says that "Moon is appalled by the shift of a glacier that leads to a man straightening his tie", which is an example of the butterfly effect, a phenomenon Stoppard explore in *Arcadia* (1993).

[9] George Moore the philosopher tries to illustrate the Zeno's paradox of infinite points in finite distances "which showed in every way but experience that an arrow could never reach its target."

[10] Henry Carr's befuddled memory is the space in which *Travesties* gets staged. *Arcadia* is set in a similar space across two literary time periods.

ARCADIA

Then maths left the real world behind, just like modern art, really. Nature was classical, maths was suddenly Picassos. But now nature is having the last laugh. The freaky stuff is turning out to be the mathematics of the real world.

(Valentine to Hannah,65)

Stoppard's reputation for speculating and subsequently reformulating a familiar situation into an unfamiliar one gets further validated in *Arcadia*, as he uses the characteristics of literary history in contrast to those in the contemporary world to examine and question the seemingly irreconcilable differences between the two. The play opens in Sidley Park (a country home in Derbyshire) at the cusp of the Enlightenment and Romantic periods, occasionally leaping forward into the modern world so that the narrative is split temporally but proceeds in parallel, allowing Stoppard to project the philosophical preoccupations of each period on the other. Featuring a bare and minimalistic stage layout common to both periods, the long central table accumulates props through the course of the play, and characters literally reach through time to pick up and use fragments in the space-time continuum. This thematic trope introduces an element of dramatic irony because although the events indigenous to each period unfold linearly, the chronology isn't mirrored and information gets recovered in haphazard fragments, lending a chaotic impression to the plot progression. Chaos in the narrative structure is orchestrated, corresponding directly to its content, and using that as its background the play explores the unpredictability and irreversibility of time, the desire for order and their subsequent effect on human relations.

PREMISE

Aristocrats in the year 1809 could afford to spend exorbitant amounts of money on employees ranging from butlers to stable boys. They could also afford to host multiple guests for extended periods of time and go hunting on their grounds for leisure, all the while reminiscing fondly

about the age of enlightenment. In 1993, not even the Lady Croom is exempt from industry and needs to do research in order to establish a name for herself outside of her nominal title. The modern world has no time for wooing and seduction, for learning how to waltz while also doing algebra because status is acquired through specialization in a field, and a continual churning of information is necessary to remain afloat in the intellectual community. Nonetheless, a reverence for the past is pervasive in the modern context of the play. Hannah has a published book on Caroline Lamb,[1] and yet she's back at work to write a new book about the Sidley hermit, gathering as much information as possible while simultaneously helping Lady Croom with research on gardening history. Valentine uses all the game books and family legacy to work on population dynamics, and has friends who analyze linguistics and sentence structures to try and link authors to anonymous works. Bernard Nightingale too is a researcher, enamored by the poetry of the Romantic period and housing a burning desire for fame. The common trait in all of them is their obsession with history, which is all too similar to the characters of the earlier portrayed period and their preoccupation with all things classical and 'regular'.

While working out the mechanics of the play, Stoppard was reportedly "thinking about Romanticism and Classicism as opposites in style, taste, temperament, art . . . [but that] the romantic temperament has a classical person wildly signaling, and vice versa" (Fleming, *Finding Order Amidst Chaos,* 194). However, more-so than temperaments, I think the dialectic of past and projected developments in science (not to mention the fortuitous fact that Newtonian physics began to get destabilized right around the early nineteenth century) lends the play its

[1] Caroline Lamb is famous for her affair with Lord Byron, and the description of him being "mad, bad and dangerous to know" is attributed to her. In this play, Hannah has written a book *Caro* through a feministic perspective, wherein "Byron [is] the spoilt child promoted by his gifts by the spirit of the age [and] Caroline [is] the closet intellectual shafted by a male society" (Stoppard, *Arcadia*, 85).

contemplative richness and a binding structure. That "shifting scientific paradigm" was an excellent parallel to the differences between classic and romantic temperaments, and Stoppard chose to double the mirroring effect by surveying it between the two periods, as well as within them (Fleming, 195).

EMOTION ACROSS THE AGES

The action in the nineteenth century begins with a clear demarcation between childhood and adult tendencies, providing a contrast in receptivity and resilience to change, but the three-year span of the narrative blurs the lines between the two. Keeping in line with period conventions of the aristocracy, adult relationships are rife with scandal. Almost every factor that contributes to moving the narrative forward has sexual undertones, and even Culpability Noakes[2] – whose sole ambition is to convert the pristine landscape into ruinous crags – contributes to furthering gossip about illicit sexual behavior in the household.

Thirteen-year-old Thomasina Coverly on the other hand, expresses an innocent apathy towards carnality, castigating the historical figure of Cleopatra for "making such noodles of [her] sex," preferring to focus instead on her geometry and Latin. Compared to the adults in the household who are appalled by the imminent and seemingly unnecessary changes to Sidley Park, Thomasina embraces the transformation from "an Englishman's garden [to] a haunt of Corsican brigands," complimenting Noakes' plans as being those of a Salvator[3] (Stoppard, *Arcadia,* 20). Three years down the line however, we see Thomasina wanting to marry Lord Byron, seeming to subscribe to the conventions of society; one cannot help but wonder if every young girl descends the same path and gets calcified into a borderline ignorant, inflexible Lady of the Manor figure

[2] Lady Croom puns on Capability Brown, one the most famous landscape gardener of the eighteenth century.
[3] Salvator Rosa, a Baroque Italian painter renowned for being 'proto -Romantic.'

that her mother typifies. These apprehensions are easily dispelled when we see that Thomasina is no ordinary child and exhibits a remarkable understanding and intuition of scientific theories and their implications.

Depicted in sharp contrast to the earlier period is the muted sexuality of the modern characters. Chloe is probably the only character who can verbalize her emotion and notice indications of it in others. The rest are either too shy and attempt to express themselves using tokens like bicycles (her mother) and apples (Gus), or are too captivated by their research to focus elsewhere. In fact, most instances of passion portrayed in the modern period are driven by heated arguments about research content, practices, and methodology.

This observation about the range of sexual expression is relevant because Stoppard has been criticized for the excessive intellectual content of his work at the expense of real emotion. Although his inhibitions about expressing his thoughts on love did lessen over time and are manifested more directly in *The Real Thing* and *The Invention of Love*, Stoppard's understanding of emotion as an incentive for action is fairly ubiquitous in *Arcadia*. On discovering that Septimus Hodge gave "the charming spirited" Mrs. Chater "a perpendicular poke in the gazebo," her infuriated husband challenged Septimus to a duel (*Arcadia*, 15-16). However, his desire for fame and for a good review of his novel overrode his fit of jealousy, leading to a temporary truce between the two men. A similar fit of jealousy, but this time commingled with a sense of hurt and betrayal (Lord Byron, whom she fancied, was also having relations with Mrs. Chater) causes Lady Croom to kick the entire party of guests out of her manor.

ART VERSUS SCIENCE

In the modern context, arguments about the importance and relevance of their work cause shifts in the characters' priorities and sense of identity. Bernard the stubborn professor of literature is

convinced that he has made a significant discovery about Lord Byron that will propel him into prominence. Despite cautions from both Hannah and Valentine, he discards the need for hard evidence to back his claims, using a probabilistic approach instead. When he "jeeringly" dismisses Valentine's objection to his practice of drawing conclusions and ignoring contradictory evidence, things get ugly.

> **Valentine** *(casually)* Well, it's all trivial anyway
>
> **Bernard** What is?
>
> **Valentine** Who wrote what when . . .
>
> **Bernard** Trivial?
>
> **Valentine** Personalities
>
> …
>
> **Bernard** Oh you're going to zap me with penicillin and pesticides. Spare me that and I'll spare you the bomb and aerosols. But don't confuse progress with perfectibility. A great poet is always timely. A great philosopher is an urgent need. There's no rush for Isaac Newton. We were quite happy with Aristotle's cosmos. Personally I preferred it. Fifty-five crystal spheres geared to God's crankshaft is my idea of a satisfying universe. I can't think of anything more trivial than the speed of light. Quarks, quasars – big bangs, black holes – who gives a shit?
>
> …
>
> **Valentine** (to Chloe) He's not against penicillin, and he knows I'm not against poetry. *(to Bernard)* I've given up on the grouse.
>
> (Stoppard, *Arcadia,* 86-88)

In their attempt to take a stand for their respective fields, Bernard and Valentine get polarized into saying things they don't even mean. The emotional effect of this conversation influences Valentine to lose hope and give up on his graduate research in population dynamics because he loses faith in his ability to uncover the underlying pattern. At the same time, their conversation serves to exemplify the resistance to change in the face of a longstanding convention. Bernard's comment about preferring the Aristotelian concept of the cosmos gets to the heart of what the play explores, especially through the perspective of children as opposed to adults. The age divide is why Thomasina accepts the impending doom of the world with cheerfulness whereas it drives Septimus into a frenzy he never recovers from. However, as Hannah points out, "English landscape was invented by gardeners imitating foreign painters who were evoking classical authors," and the only thing that has remained constant through time is the desire for change in the direction of the ideal, or progress, as is with science (40).

DEFYING CONVENTIONS: A COPERNICAN THOMASINA

The trajectory of scientific progress has never been smooth, because it has necessitated humans to shift away from a deified perspective of themselves into one that involves apes. Stoppard allows his play to unfold in a similar manner, wherein he has Thomasina begin posing innocuous questions, which over the course of the narrative blossom into powerful ideas that anticipate leaps in scientific history spanning centuries, and hence require a massive adaptation of mentality in a classical audience. While stirring jam into her rice pudding, Thomasina makes the observation that "if you stir backward, the jam will not come together again" to which Septimus has the logical answer that one "cannot stir things apart [because] time must needs run backward" (Stoppard, *Arcadia*, 12). This doesn't silence the whirring gears in Thomasina's mind, and on the contrary, she draws a conclusion about the deterministic nature of the universe.

Simply put, if the universe were to be a Newtonian wherein every action has an equal, opposing reaction, "you could stop every atom in its position and direction, and … if you were really, *really* good at algebra you could write the formula for all the future," and so begins Thomasina's quest to uncover the mysteries of the world (13). Exciting and overwhelming as it is, Thomasina neglects to acknowledge the flip side to this model of the universe, namely the question of free will. Were the universe to be deterministic, and were every atom to be Newtonian, humans would be enslaved to their internal chemistry and be unable to control even their own decisions. Stoppard conveniently side-steps that question on a scientific level – raising it in *The Hard Problem* instead – and explores its effect within human interactions.

Complicating matters even further is Stoppard's engagement with the art of the plausible, and the relevance of that to the scientific issues explored in this play. In an effort to distract her while he attends to businesses of carnality and duels, Septimus assigns Thomasina the (nearly) impossible task of finding the proof to Fermat's last theorem,[4] the pursuit of every mathematician given this frustrating fact:

> **Septimus** In the margin of his copy of *Arithmetica*, Fermat wrote that he had discovered a wonderful proof of his theorem but, the margin being too narrow for his purpose, did not have room to write it down. The note was found after his death, and from that day to this –
>
> **Thomasina** Oh! I see now! The answer is perfectly obvious.
>
> **Septimus** This time you may have overreached yourself.
>
> …

[4] The Diophantine equation, $x^n+y^n = z^n$ is an extension of the Pythagoras theorem. Fermat's last theorem states that this equation has no solution for $n > 2$. A proof was finally formulated by Andrew Wiles in 1995 for which he won the Field's medal.

> **Thomasina** There is no proof, Septimus. The thing that is perfectly obvious is that the note in the margin was a joke to make you all mad.
>
> (Stoppard, *Arcadia*, 14)

It is entirely plausible that Fermat's intention was to make future mathematicians mad, or that he couldn't admit to having no proof to his own theorem. Were this to be true, it would mean not only that Fermat was a sadistic mathematician with an ego problem but also that when people are informed about the existence of a thing, they don't rest until they find it. Philosophy and science were conceived, and continue to exist because we are still on the quest to find the meaning of life, even if there is possibility that the hunt is futile.

The possibility of the futility and/or triviality of the hunt is one that plagues Valentine. Along with his cynical "Oh the grouse. The damned grouse" he mentions his belief in the plausibility of the afterlife, and Hannah shoots back with "It's wanting to know that makes us matter . . . Believe in the after, by all means, but not the life. Believe in God, the soul, the spirit, the infinite, believe in angels if you like, but not in the celestial get-together for an exchange of views. If the answers are in the back of a book I can wait, but what a drag" (106). Hannah's views are echoed later in *The Hard Problem* as well, and they serve to emphasize the necessity for people to continue their quest for knowledge, despite the fact that it may shake up previously held notions.

After centuries of classical physics governing the scientific world, a different set of rules invaded the space. "Relativity and quantum physics looked as if they were going to clean out the whole problem between them. A theory of everything. But they only described the very big and the very small. The ordinary sized stuff which is our lives … [is] as mysterious to us as the heavens were to the Greeks" (68-69). In the spirit of her time, Thomasina seeks to describe the

ordinary that surrounded her life. Disillusioned with the banality of Euclidean geometry, Thomasina believes that "if there is an equation for a curve like a bell, there must be an equation for one like a bluebell, and if a bluebell, why not a rose?" because otherwise "God could only make a cabinet" (55). This revelation leads to her attempting to develop "a method whereby all forms of nature must give up their numerical secrets and draw themselves through number alone," which in the present world describes Fractal Geometry (55). Valentine of the twentieth century, and mathematician of Sidley Park explains that her method "starts with an equation and turns it into a graph [whereas he has] got a graph and [he's] trying to find the equation that would give you the graph if you used it in the way she's used hers. Iterated it" (65). Much like the position of an electron in *Hapgood*, the equation works such that "you'd never know when to expect the next dot. But gradually you'd start to see this shape, because every dot would be inside the shape of this leaf" (68).[5] In a sense there is an algorithm that describes the future of the position of a point, but there is an inherent uncertainty to it that opens the closed doors of determinism into a range of possibilities for exploration.

Valentine is very excited by the pursuit of the unknown, saying that "the unpredictable and predetermined unfold together to make everything the way it is. It's how nature creates itself, the snowflake and the snowstorm" (68). These describe dynamical systems in nature, where a system in a stable state can suddenly and unpredictably bifurcate into an oscillatory or unstable state. Every once in a while, it bifurcates multiple times, doubling, tripling and quadrupling its period *ad infinitum* until the system looks like it is in utter chaos[6]. However, because of the equation governing it all, there is an order amongst that chaotic behavior. The

[5] See Figure 1 An algorithm iterated ten thousand times to produce a self-similar leaf.
[6] Similar to the self-regenerating heads of the Lernean Hydra from the second labor of Hercules.

consequence of orderly patterns among chaos implies that “six thousand years in the Sahara looks like six months in Manchester,” that is, the pattern is the same, but the scale is vastly different (69). This idea had an immense metaphoric appeal to Stoppard because not only did it give him an opportunity to represent human life as a series of seemingly random events, but it also gave him the freedom to condense two centuries worth of scientific discoveries to three years of a young girl’s life.

DISCARDING THE NEWTONIAN UNIVERSE

Mathematically speaking, Bernard sees things as a binary and that the probability of getting a zero or a one is dictated by hard probabilities. Hannah, on the other hand, is open to considering multiple explanations for a problem, and hence exhibits a more scientific outlook towards life. While reading up on her own research she finds out that “the hermit [of Sidley Park] was born in the same year as Septimus Hodge” leading to her hypothesis that maybe Septimus was the hermit who went insane. However, unlike Bernard who rushes to be featured on “The Breakfast Hour” as soon as he suspects Byron of murder, Hannah waits until she stumbles upon a picture of Septimus holding Plautus (his tortoise) before publishing anything (Stoppard, *Arcadia,* 94,126). The interesting thing about the way their personalities get manifested is that since Hannah is a great admirer of the classical, and Bernard a romantic, one expects her to be rigidly Newtonian in her approach and him to be open to irregularity. However, Fleming says “while Bernard’s arrogance and lust for fame are obvious character flaws, his more subtle shortcoming is that his sought-after explanation is based on a Newtonian paradigm of complete order; that is, it ignores the complexities and contradictions of real life,” and that essentially, he assumes a strict linearity of cause and effect (Fleming, 202).

On dissecting Bernard's argument, it is unsurprising that he leaps to the conclusion that Byron murdered Chater. That Chater's notes addressed to Septimus were left in a book that he lent to Byron, and that Byron did have relations with Mrs. Chater but it caused grief not to her husband, but to Lady Croom, are details that fell through the cracks in history. Verbal information cannot possibly be as extensive as written records, and it is a misalignment of knowledge that led to Bernard's fiasco. Stoppard refers to this lack of synchronization in a less direct form as he employs the use of translation of Latin into English. The first instance is of Lady Croom misinterpreting "Et in Arcadia Ego" to depict God's unchanging plan for paradise when instead it refers to the omnipresence of death (Stoppard, *Arcadia,* 23). "Oh phooey to death" exclaims Thomasina, showing a maturity beyond her years for the inevitability of an end and an emphasis on the present (25). The second instance again involves Thomasina, except in this case it is an exercise of retranslating Shakespeare from Latin unbeknownst to her, wherein the crudity of her translation renders the passage abysmally prosaic. That the delicate balance of language and expression can be thwarted by a simple doing and undoing of an action is further validation of the fact that God is not Newtonian. A mistranslation caused the atom bomb to be dropped in Japan,[7] and a gardening record attributing the discovery of a new species of dahlia to Ezra Chater caused Bernard's public humiliation. The smallest of actions can have unpredictable effects and it is this aspect of the ordinary that makes life worth living.

Septimus was not aware of the unpredictable determinism that rules the natural world and went "off his head," covering reams of paper with "cabalistic proofs that the world was coming to an end" (43). To be sure, Thomasina's fractal geometry gets at that very concept but the

[7] The Japanese word *mokusatsu* literally translates to "kill with silence." When issued an ultimatum by the US, the Japanese responded with this word, intending it to mean 'reserving comment,' but was misinterpreted as them ignoring the ultimatum. See *The Fall of Japan* by William Craig.

notion of iterating towards irregularity subsumes the unpredictability inherent to the mechanism. Her other question, however, the one concerning the deterministic nature of the world gets developed further when Septimus hands her a recent publication, and Thomasina, thumping the book down on the table goes:

> **Thomasina** Well! Just as I said! Newton's machine which would knock our atoms from cradle to grave is incomplete! Determinism leaves the road at every corner, as I knew all along, and the cause is very likely hidden in this gentleman's observation.
>
> **Lady Croom** Of what?
>
> **Thomasina** The action of bodies in heat.
>
> (Stoppard. *Arcadia*, 118)

Punning on the theory that "the universe is deterministic all right … but the only thing going wrong is people fancying people who aren't supposed to be in that part of the plan" that Chloe proposes, Thomasina is in fact anticipating the second law of thermodynamics (104).[8] Related to bodies having different temperatures, the law implies that the flow of heat is unidirectional, therefore directly contradicts Newtonian bidirectionality. Additionally, it comes with the clause that some of the heat gets dissipated in the process. Valentine explains it better with an example of a ball breaking a window. "You can put back the bits of glass, but you can't collect up the bits of the smash" meaning that try as one might, the heat will eventually "go into the mix" (132). Energy will be converted into entropy, leading to the heat death of the universe, stirring "disorder out of disorder into disorder until pink is complete, unchanging and unchangeable" just like porridge (12).

[8] The first law of thermodynamics states that the total energy of an isolated system remains constant, while the second law states that the total entropy, or disorder, of an isolated system increases with time implying an irreversibility in the flow of energy.

"The Improved Newtonian Universe would cease and grow cold" remarks Hannah, as she grasps the concept, and dejected as she feels, her unhappiness cannot compare to Septimus' because his fundamental ideology rests of the assurance that everything in the universe if lost, is recoverable (132). Stoppard gives us a window into this mentality during a discourse with Thomasina. Reflecting on the great library of Alexandria going up in flames almost has her in tears and she bitterly wonders "how can we sleep for grief?" (56). To this, Septimus confidently asserts that there is no cause for worry, and that they must "count their stock" and celebrate the art that did persist, because:

> The procession is very long and life is very short. We die on the march. But there is nothing outside the march so nothing can be lost to it. The missing plays of Sophocles will turn up piece by piece, or be written in another language. Ancient cures for diseases will reveal themselves once more. Mathematical discoveries glimpsed and lost to view will have their time again.
>
> (Stoppard, *Arcadia*, 57)

He *is* correct about the mathematics getting rediscovered, especially with respect to all of Thomasina's theories that surfaced years after her death, although I have trouble believing that art can be recovered in its original form, given the simple exercise in (re)translating Shakespeare that proved to be unsatisfactory. The point of this excerpt however, is to establish Septimus' endorsement of the view that time is infinite and all the knowledge in the world is recoverable, and how his worldview is completely dismantled by the prospect of a universe that succumbs to the laws of thermodynamics.

A CHAOTIC STRUCTURE

The genius of Stoppard extends not only to simplify and weave issues of chaos theory into the forefront of his audience's consciousness, but his precision and meticulousness dictates that he attempt to incorporate the content into the narrative structure. Fleming dissects the scene-by-scene composition of the play and points out that the plot progression bifurcates alternately into the two time periods, eventually descending into chaos as in the final scene the characters and dialogues are "doubled by time" in the same space while music bleeds through the ages (203-204).

Perhaps unintentionally, Stoppard also happens to have incorporated a dynamical systems approach in the plot construction: the narrative is strewn with stable fixed points that bifurcate into instability. This is most evident on an emotional scale, when characters unexpectedly exhibit extremely strong reactions in response to a situation. For instance, Mrs. Chater's infidelity was a well-known fact, with Septimus brashly referring to "her readiness that keeps her in a state of tropical humidity" (Stoppard, *Arcadia*, 15). Apart from the easily suppressed altercation with her husband, her affairs were of scant consequence until Lady Croom's emotions got involved and the system, as it were, spiraled out of control and got overturned in the course of hours. Bernard and Valentine were relatively reasonable until they got blindingly defensive about art and science, falsely supporting unstable views that neither believed. The most compelling example is Septimus, who is described as "blithe, witty and apparently completely unperturbable" (Edwards 182). However, one scientific discovery about a possible end to time tipped him over the edge to become the Sidley Park hermit that Hannah ended up studying.

Over hundreds and thousands of years, forms of energy morph into one another and heat dissipates to ultimately drop the temperature of the universe to an absolute zero. And yet, over

generations, chemicals rearrange themselves to produce more and more complex internal structures that seem to contradict the notion of entropy by expanding the conscious capacity of beings. Information in the contemporary world increases exponentially and so does knowledge. Thomasina and her knowledge were consumed by the flames like the library at Alexandria, but in rejection of an absolute end, it resurfaced after years, just like the proof of Fermat's last theorem.

HAPGOOD

There is a straight ladder that leads from the atom to the grain of sand, and the only real mystery in physics is the missing rung. Below it, particle physics; above it, classical physics; but in between, metaphysics.

(Kerner to Hapgood,545)

The iterated equations in *Arcadia* produced structures that resembled an infinitely scaled synecdoche where each part contained the whole. *Hapgood* on the other hand uses a different type of scaling: it involves an infinite stretching of atomic properties to describe not only movement and physicality in humans but to encompass nuances of human behavior. Although there are allusions to two sides of the human temperament in *Arcadia,* it is "by no means in the foreground. And yet, it's firing all around target, making a pattern around the target," like a region of probability of the position of an electron, and it seems fitting that this concept be explored in detail in *Hapgood* (Fleming, *Finding Order Amidst Chaos,* 195). In his introduction to the play, Fleming quotes Stoppard as saying, "I was fascinated by the mystery which lies in foundation of the observable world, of which the most familiar is the wave/particle duality of light. I thought it was a good metaphor for human personality" (175). Double agents, spies with volatile personalities and complicated pasts act as the elements and catalysts in an experiment, reacting to situations and mirroring unintuitive scientific concepts to produce a play that is both intellectually dense, and riveting.

SETTING AND STRUCTURE

Set in the late 1980's, *Hapgood* derives its name from the fiercely strong woman who runs the British Secret Service and whose operation is being threatened by an internal double agent. The opening scene in the original production featured "a red dot [moving] about a map of London that is projected onto panels," tracing the movements of men being followed by the British secret service: an accurate estimate of their location but not necessarily their identity, giving "the

audience the vicarious pleasure of spy surveillance" (Fleming, 182). The visuo-auditory opening transitions into a choreographed exchange of towels and briefcases in the men's changing room of a municipal swimming-baths. The audience is invited to infer the rules of exchange for themselves, overwhelmed and bemused for the most part by swinging cubicle doors and characters walking on and off stage in swimming trunks. What gets revealed through barked commands and spy jargon is that whatever the purpose, the operation was an utter failure. Kerner, the scientist working for the British Secret Service as a double agent, was suspected of leaking classified information to the Russian government, but the trap that was set up to catch him in the act mysteriously backfired on the executors.

The first scene sets up the audience to expect a spy thriller, one where various suspects are interrogated, and a set of clues uncovered in the right order points towards the culprit: in short, a whodunit. However, Stoppard seeks to make this play deviate from the genre, and have it closely resemble a "scientific paper in which the denouement – the discovery – is announced at the beginning" (Fleming, 180). The perpetrator is revealed (to be Ridley) very early in the play, and the story becomes more of a *how*dunit. Naturally, the decision to adopt this approach is an example of the Stoppardian trope of designing structural elements that reflect the content of a narrative, but it has also been done for reasons of etiquette.

> When I write an experiment I do not wish you to be *surprised*, it is not a *joke*. This is why a science experiment is a beautiful thing: first, here is what we will find; now here is how we find it; here is the first puzzle, here is the answer, now we can move on. This is polite. We don't save up all the puzzles to make a triumph for the author.
>
> (Stoppard, *Hapgood,* 543)

Interpreting this quote rather literally, Katherine Kelly argues that more so than a scientific paper, Hapgood is set up as a scientific experiment wherein “act 1 leads to a hypothesis, act 2 carries out the experiment” (*Tom Stoppard and the Craft of Comedy,* 155). Broken down further, the first scene is the failed execution of an experiment, due to the lack of sufficient evidence to establish Kerner’s guilt. Were the narrative to be reorganized chronologically, Ridley’s involvement in the two busted operations in Paris and Athens would be the analeptic events that corroborated the subsequent hypothesis that Ridley was to blame. The design of the second experiment occurs off-stage, and in that sense Stoppard isn’t entirely being polite. However, as Kelly points out, a completely transparent script “would fail to give the [audience] the pleasure of discovery” (Kelly, 154). The execution of the experiment happens on stage, and although well thought out, the lack of constancy of human character complicates matters considerably.

Kerner is portrayed as the idiosyncratic foreigner, with a formidable intellect and a mellow disposition acquired through his profession as a scientist. His constant desire to get words and meanings right is endearing, and adds to his scattered yet precise personality such as him interrupting his own ruminations on Einstein’s religious crisis with “what is a hamster by the way? No tell me in a minute.” In some contexts, this trait lends humor to the scene, but in most others it serves to reveal his ideology and important plot clues (Stoppard, *Hapgood,* 545). Through most of the action, Kerner’s voice acts as the meta-narrator, describing the plot progression and structure, along with exhibiting a keen understanding of people just by drawing analogies to science.

PLOT MECHANICS

Immediately after the meet at the pool, Blair corners Kerner at the zoo in an attempt to gauge where the latter's loyalties lie, going over the mechanics of the trap they had laid out for him, expressing his vexation at the fact that they couldn't figure out *how* the job got botched. It transpired that Kerner's briefcase had been emptied of its contents, and since the bleep stopped transmitting a signal and none of the agents gave off a Geiger reading, it seemed as if the job was done by "Mr. Nobody" (504). Blair is confused by the events of the morning because he concludes that had the person removed only the extra information being leaked, the agency would have been "none the wiser" (504). The same question bothers Wates, the suave CIA agent, and it is here that Kerner exhibits his logical brilliance when, without missing a beat he responds that "obviously because he put *in* a roll of film and they all look the same; he had to take them all" (504).

The other issue revolves around the identity of the Mr. Nobody, and although Hapgood and her agents have reason to suspect Ridley, they cannot figure out how he managed to pull off the operation. Hapgood realized that the two Russians sent instead of Georgi "were expendable, they were meant to be seen" because their presence served as a distraction from Ridley being observed and his cover being blown (508). Wates fell for that very trap, and "nearly cut himself shaving, he was so fascinated," and was going to do a diagram of the movements during the exchange (508). Kerner however, immediately recognizes that Wates' diagram was in essence "the bridges of Konigsberg, only simpler" (542).[1] This is a classic problem in mathematics

[1] See Figure 2 The Seven Bridges of Konigsberg, solved by Leonhard Euler. Kerner says: "Imagine nutcrackers with one bridge across the handles and one across the hinge and four bridges on to the island which would be a walnut if you were cracking walnuts" (541).

which originated with the citizens of Konigsberg[2] attempting to navigate the city by crossing each of the seven bridges exactly once, and ended with Euler's generalizations in graph theory and positional geometry. He proved that "it can't be done, you need two walkers," and in this situation Kerner explains, the only way to explain the discrepancy is the involvement of a Ridley twin (542).

Hapgood and her agents decide that the way to trap Ridley is to make him believe that they are both prime suspects in the investigation (seeing as Hapgood was his only alibi in all three of the failed operations) and that both of them need to face temporary suspension. In a "friendly interview" that Blair holds in Hapgood's office, Blair and Wates try and throw Ridley off track by framing Kerner, who "made up the truth" about being converted back into a Russian spy from his official position as a British joe (548, 592). During the meeting, they stage a revelation about Hapgood's son being kidnapped, and this time, it is the 'personal' that interferes with the 'professional'. Throughout the play, Hapgood is depicted as self-confessedly making allowances for her son, speaking of her "intelligence network as the only one in the Western hemisphere [exhibiting] seasonal fluctuations, and it is only a matter of time someone works out it's the school holidays" (514). Given that she will do anything for her Joe, she tells Ridley that she is willing to exchange the tape containing real secrets, but unfortunately the only way to do so is with the help of her (pseudo) twin sister.

[2] Incidentally, Kerner's character in the play was born in Kaliningrad, which had earlier been Konigsberg. He mentions that he just missed being German instead of Russian, and Fleming attributes that too as a feature of double-ness in his identity.

SCIENCE SEIZES THE SPY WORLD

Speaking of prime suspects, all through the two scenes in which he is being cross-examined by Blair, Kerner lapses into explanations of scientific theories that turn out to be extremely relevant analogies. They are also veiled confessions of his guilt, but the intellectual weight of the discussion turns out to be an excellent distractor from the matter at hand. He muses about the usage of the word 'prime' in association with suspects, saying that they "don't divide nicely … It's the last thing to expect from a suspect. You must look for *squares*. The product of twin roots" (572). Just like the root of a number can be both, positive and negative, people too can be seen as having more than one identity. "We're all doubles … The one who puts on the clothes in the morning is the working majority, but at night – perhaps in the moment before unconsciousness – we meet our sleeper" (Stoppard, *Hapgood*, 572-73). This was the concept that intrigued Stoppard, the exploration of dualities or the double nature of human personalities. He referred to the mechanics of the plot as "just a necessary nuisance to provide an opportunity to write about this woman who in Blair's words is 'sort of a double,' and the way this bears upon her relationships with Blair, Kerner and Ridley" (Fleming 178).

Infinitely more exciting than a number having two distinct square roots is the ability of a single electron to be in two places at once. Kerner says that it "defeats surveillance because when you know what it's doing you can't be certain where it is, and when you know where it is you can't be certain what it's doing" because as an electron jumps from one state to another, losing a packet – or quantum – of energy, and at that moment of the quantum jump, it is like two electrons (Stoppard, *Hapgood*, 544-45). This quality makes "the particle world the dream world of the intelligence officer," implying that the best alibi for a double agent is himself, or in the real world, a secret identical twin (544). Stoppard manipulates this trait theatrically by having

characters transition from one location to another without passing in between, such as Blair switching from the pool to the zoo, or by having a character transition into another, such as in the 'inter-scene,' where Ridley remains on stage, except "he is carrying a suitcase [and] is a different Ridley," i.e. his twin (570). Along with the physical analogues however, Stoppard recognizes that the spectrum of human emotions in relationship to quantum particles is an interesting one to explore as well.

TWINNING

Celia Newton invades the stage like a slap in the face. Frumpy, irresponsible, cluttered, and with a house reeking of marijuana, Celia makes no effort to hide her expletives in 'sugar' and 'ff-fiddles.' She is caustically critical of Betty (Hapgood), and does an incredibly convincing act of a jealous sister. Ridley is completely nonplussed, saying "she may be your twin, but there the resemblance ends. She's a pothead, it reeks … she won't stop talking, she picks her nose, she looks like shit," and compared to the woman who plays chess through memory alone, and is thoughtful enough to buy a single lemon for Wates' tea, the disparity is alarming, but crucial in emphasizing Hapgood's double nature (566). Blair says that he always suspected her of being "a little anarchist," but the scene involving Celia reveals that the problem has always been about reconciling the 'personal' with the 'technical' (561). Demastes suggests that it is a sort of schizophrenia, proposing that being Celia allows Hapgood to analyze the suppressed aspect of her personality.

In subscribing fully to the act of playing her antithesis, Hapgood embraces that personality, and combined with the personal-technical conundrum, she not only sleeps with Ridley, but also warns him of a possible trap because "his desire to save her son makes him worthy of being allowed to escape" (Fleming, 186). In a nasty outburst at the shooting range, he

accuses Elizabeth of wanting to sleep with him if only she could “pull her bodice up past her brain,” and Celia is exactly that, an Elizabeth “without the brains or the taste” and hence a fulfillment of his fantasy (Stoppard, *Hapgood*, 540, 585).

Unlike Celia Newton, Ridley’s twin gets barely any stage space. He is a silent presence, visible only during the two meets and the brief inter-scene. Although we know that he is the other half of the famous KGB twins, his mentality and personality are completely obscured, and being given the opportunity to examine them would be interesting, especially because Ridley himself is complicated. He has an adventurous streak, and his moral compass is of dubious nature given that he is a double agent, and that he has no qualms about committing murder; nonetheless he goes out on a limb to help get Hapgood’s son back. “He is ultimately two discrete Ridleys occupying one body, muddling his affairs by remaining in the realm of either/or” and exhibits schizophrenic behavior similar to Hapgood herself (Demastes, 82). In the light of this perspective, it would be interesting to explore newer discoveries in quantum mechanics and their relation to twinning. Quantum entanglement is described as a pair of particles with opposite quantum properties separated in space, wherein the manipulation of one particle causes changes in behavior in the other, and drawing analogues to separate halves of human personality would be a splendid thought experiment.

Not just on the level of twins, the question of doubles is a pervasive one in the play, and Fleming points out how the “structure engages the theme of duality, as nearly every one of the twelve scenes has a double” (181). He explicates how there are two scenes at the pool, two zoo scenes with Kerner and Blair, two rugby scenes showing Hapgood’s “relationship not only with her son but also with the two men whom she loves,” two office scenes, and two involving Ridley and Celia (181). The scene at the shooting range is the only outlier, and Fleming explains away

the potentially problematic office scene involving Ridley and Celia by interpreting it in the light of her exhibiting her dual personality within it. Hapgood transitions from the crude Celia snapping “don’t fancy your fuckin’ chances,” to calmly saying “yes Maggs – everything’s fine. Queen to king one” in a matter of minutes (580,582).

Stoppard based his play on “three central conceits,” the first of which was to have a “physicist who loses faith in certainty because of uncertainty” (Fleming, 178). However, it seems to me that Kerner’s ability to see double-ness in everything makes him the most successful character. Demastes too talks about Hapgood’s conversion to Kerner’s way of thinking, and Blair and Ridley’s rigid inability to do so. Near the end Hapgood realizes the inanity of the espionage circle when she exclaims “*What network?!”* and in reference to the opposition, correctly reasons “we’re just keeping each other in business, we should send each other Christmas cards – oh f-f-fuck it, Paul” (Stoppard, *Hapgood*, 591). Because of her professionalism and either/or outlook in the past, she preferred to raise young Joe as a single mother over letting Kerner’s identity be dismantled, a fact that she presumably regretted and Kerner most definitely resented. “Cohesion of being is not singularly linear but multiple and simultaneous,” Demastes observes, and advocates for a non-binary outlook on life (83).

MORALITY AND RATIONALITY: A DOUBLE-EDGED SWORD

Stoppard chooses the unconventional choice of a zoo as a background for a Blair and Kerner to have a chat, twice. The first scene is a discussion of the failure and perplexities surrounding the meet at the swimming pool; the second is the staged interrogation that took place in Hapgood’s office. Both times, Kerner’s character and loyalties are under scrutiny, and both times he confesses to being guilty without feeling any guilt about his actions. Much like the invisible bars of the cage that cast a shadow on his face, Kerner is trapped in a quandary. “A double agent is

like a trick of the light," he says, explaining the double slit experiment in physics involving a beam of light being shone into a box wherein one can demonstrate that light behaves both as a wave, and as particle (Stoppard, *Hapgood*, 500). Because Kerner believes that he is inherently double, he says he "frankly [doesn't] remember which side [he's] supposed to be on," and that he doesn't even necessarily have to, so comfortable is he with the uncertainty (501). Blair (irritably) understands the concept, but cannot seem to translate it to reality. He wants to know whose side Kerner is on, the "what's what" of things, a trait that he doggedly adheres to until the end of the narrative, and which unfortunately leads to his downfall (500).

Kerner also refers to the observer effect, an extremely non-intuitive concept in particle physics wherein the act of observing a phenomenon alters the state of the particles being observed. With respect to the narrative being an analogy for a research project, this concept is put into use in both the experiments that were performed. The team had designed the morning's exchange with the purpose of determining Kerner's allegiances. In mathematical terms, their null hypothesis was Kerner's innocence, with a Geiger reading and the transmission of a 'bleep' being evidence of his guilt. Translated to the duality of light, they were attempting to see if Kerner's trajectory was straight like a bullet, or bent like a wave, and all of the evidence pointed not to his being a bullet, but to Ridley's being a wave. The irony and brilliance of the setup of the plot is that on the flip side, during the process of deceiving Ridley into believing that he wasn't a suspect, Kerner confessed to leaking his research and himself being bent. The two double agents acted exactly like a trick of the light, and exposed their nature only when the scientists/ secret service agents weren't explicitly trying to observe their actions.

It is during the second conversation at the zoo that Kerner reveals that his original motive for coming to Britain was the simple matter of technological superiority, but also says that "there

is something terrible about love.[3] It uses up all of one's moral judgement," and in conjunction with his earlier assertion that the secrets were his to give up, it is a clear indication that he had been converted back to a spy (Stoppard, *Hapgood,* 573). Even so, Blair chooses to trust him, because he recognizes that Kerner's loyalties lie with Hapgood. Whether it is her technical side or her personal is a matter that he doesn't consider, because to him loyalties too are zero or one. "Oh, Paul. *You* would betray her before I would" Kerner bursts out, an assertion which turns out to be entirely true (574).

The play features several moments of unwavering loyalty, firstly when Blair refuses to let Wates coerce him into subscribing to the notion that Hapgood and Ridley were perhaps working together, and secondly when Hapgood passionately cries out "Kerner is my joe!" so convinced is she of his allegiances (538). However, Blair endangers the life of Hapgood's son by physically bringing him to the second pool meet when he had promised her that he would be kept out of it. When Hapgood says that she couldn't ever forgive him for it, Blair calmly responds "I know that. I knew that" (590). Kerner being Blair's counterpoint in this matter, gave up his program for the anti-particle trap because they threatened to kidnap Joe. His affection for his son is evident from very early in the play where he is revealed to have sent him candy, and had a picture of him tucked inside his wallet, and regardless of the anger and sense of betrayal he feels towards Hapgood, he was loyal to her on a personal level.

[3] Hilary from *The Hard Problem* would probably think of Kerner as an interesting case study.

TYING UP LOOSE ENDS

Although Stoppard mainly employed Heisenberg's uncertainty principle of electrons to explain the necessity for the KGB twins and to visually represent quantum jumps, he extended the analogy to encompass actions undertaken by the characters as well. Blair and Kerner's decisions to value the professional over the personal, and vice versa, serve to reinforce the uncertainty and unpredictability of human behavior in a situation. In his essay, Paul Edwards "is compelled to ask why [Hapgood] and her colleagues are certain that in a play illustrating the Uncertainty Principle – that Ridley will indeed summon his twin and pass a dummy disk, keeping what he thinks is a genuine disk for himself" (175). The answer lies primarily in the feelings Ridley houses toward Hapgood, and secondarily in his allegiances to the Russian secret service. Ridley says that the meet "smells like a dead cat" and suspects that the kidnapping was an inside job that Blair or Kerner had rigged; "it never smelt Russian, not for a minute," he says after being captured, indicating that he wanted to intercept the delivery and pass the genuine disk onto the Russians and finish the original job that initiated the narrative (Stoppard, *Hapgood,* 585, 587). Edwards also questions the need for a second Ridley at the exchange, but that issue is tied to the previous point about being present to intercept the disk, and the Konigsberg problem of requiring a second person.

Since Kerner's career as a double agent is over, he decides to move back to Russia. This, Hapgood correctly guesses is *toska po rodine*, or "homesickness, but squared," and she is extremely affected by his decision (Stoppard, *Hapgood,* 538). As he begins walking away, however, the game starts and "Kerner's interest is snagged" (593). Hapgood glancing back notices that he hasn't moved and the stage directions report that she "comes alive" (593). The

audience doesn’t know if he decided to stay or leave, and the play is suspended on the very uncertainty that drives its progression.

THE HARD PROBLEM

"We've accounted for every particle in the universe except for dark matter, and we're working on that. And here you are on your knees to what? To who?"

(Spike to Hilary,10)

After delving into the core of quantum mechanics and chaos theory from a humanitarian perspective and alluding to the relationship humans share with the natural and mathematical world in some of his other works, Stoppard hurls headlong into exploring questions that seem ordinary on the surface but have implications in understanding the human being as a conscious, decision making entity. For the first time, Stoppard abandons the use of analogy to explain breakthroughs in science, and indulges in a recapitulation of scientific debates that have taken place over the past half a century. Was there really enough time in the history of the world to allow for random chemical reactions to eventually lead to the bio-diversity we witness? Or was the process unwittingly helped along by creatures vying for food, who only got better through generations and eliminated the underdogs? Or is there an entirely different explanation, perhaps working in conjunction with the others, wherein there exists an inherent selfishness within the spirals of DNA that ensured that only the best would survive, while the rest perished? Moving outward from the cellular makeup, is there a continual behavioral evolution amongst humans that distinguishes us from other species, and, if so what was the point of bifurcation that made us different on the level of consciousness? *The Hard Problem* uses the lack of consensus in the scientific world as the base upon which characters explore the biological human. Given the shift in societal structure and priorities over time, Stoppard recognizes that there is no better setting for his new play than in a research lab rife with politics, and the main contributor to progress is the hunger to remain afloat and perhaps gain some recognition in a vastly competitive world.

Stoppard characteristically offsets an intellectual discussion with slapstick humor and elegant quips, but uncharacteristically, he also adds an element of explicit emotion to the mix by having his protagonist allow herself to articulate her feelings. It can be suspected that the vulnerability he introduces is a rhetoric of pathos as well as an embodiment of the message the play is trying to deliver. Since the preoccupations of this play don't exactly possess a physical component that the structure can embody, Stoppard's meticulousness manifests itself by having his characters engage personally, and not just professionally with the issues they are examining. To some degree, this mirroring quality validates their findings but sometimes it subverts them, indicating that the reason some questions remain unanswered could have to do with the sheer difficulty in summarizing a human being by a fixed set of rules.

IN A NUTSHELL

Nicholas Hytner, director of *The Hard Problem* at the National Theater opens his discussion by reading out the letter Stoppard wrote to him when he conceived of the play:

> "I want to write a character who is good, not goody-goody, and believes that goodness has an objective reality which is not captured by, explained by, defined by evolutionary science, evo-biology, evo-psychology, neo-Darwinism … the setting is based on someplace like the Allen Institute in Seattle, but we are in England. Paul Allen, ex-Microsoft has financed a Brain Science lab to investigate how brains work etc. The play's dates are to accommodate my hazy notion that my Allen is a hedge fund guy and the credit crunch is where we're headed. So, a play about evolutionary biology and the banking crisis"

Stoppard says that, to him "the concept of morality is unintelligible without consciousness," and Hilary the protagonist is an embodiment of Stoppard's philosophy. A

behavioral psychologist working at the Krohl, she is convinced of the inherent goodness in people, and is hence trying to detect the presence of altruism in humans all the while trying to decipher the origin of consciousness in humans (Stoppard, *The Hard Problem*, 13). The course of the play reveals that her primary reason behind studying the phenomenon of altruism could perhaps be driven by self-interest, which further serves to contribute to the overall problem of humans attempting to study themselves, and failing. Apart from her, much of the plot progression can be owed indirectly to the existence of Jerry Krohl (Stoppard's Allen), a "squillionaire with a Master's in biophysics who decided to try hedge funding" (13). He established the Krohl Institute for Brain Science, and for that he can technically be described as a philanthropist, but the fact that his money was acquired by manipulating people and the stock market "raises the interesting question: is Krohl an altruist or an egoist?" (13)

Regardless of the answer to that question, Stoppard admits to being very interested in the fact that Jerry Krohl is a financial trader, and given that the market displays trends of "irrational exuberance" even when "it has been established computationally that nothing can possibly go wrong" fascinated him (Stoppard, Interview with Hytner). He wanted to write a play about this subject in parallel to human unreasonableness because he saw how the two impinged upon each other, and that was by considering both systems to be purely computational. To examine the behavioral aspect of the notion of financial trading, Stoppard introduces Krohl Capital Management (KCM), home of quantitative financial engineers (or quants) who use equations to describe stock market trends and predict future behavior. As Amal succinctly points out, "the market is a belief system with a short memory, and it's leveraged on highly correlated billion dollar bets -and trillions on side bets," and the key word here is belief (Stoppard, *The Hard*

Problem, 33-34). Solely that, and not rationality, is what makes hedge funding a profitable endeavor.

ARTIFICIAL INTELLIGENCE, OR INTELLIGENT DESIGN?

The failure to explicate human behavior is the driving force of the play, with Spike the entirely rational, mathematically adept scientist acting as the primary antagonist to Hilary's optimism and faith in the human condition. Because we see Hilary saying her prayers and bursting into tears early in the play, it is very easy for a scientifically minded member of the audience to find himself identifying with Spike's rationale. As the play proceeds, however, it becomes increasingly evident that perhaps the scientific method, although rigorous, is reductionist in its approach, and Hilary's arguments begin to gain traction in comparison to those proposed by the other characters who aggressively hold onto their logic.

Years of ruminating on the unpredictable probability of the scientific world and its increasingly faithful followers has Stoppard wondering if obstinate empiricism is any different from organized religion, and whether we have closed our minds to the prospect of unknowability solely because the lack of pursuit would take away our purpose as a species. The hard problem therefore gets formulated at the point where the validity of hard evidence-based science comes into question, and for an audience member following the arguments to a reasonable extent, this is the moment when *The Hard Problem* acquires a foothold in their mind.

Proponents of the possibility of programming Artificial Intelligence – which in the present world is a significant portion of the population[1] – believe that the human brain is a

[1] In a TED talk titled "Can we build AI without losing control over it", Sam Harris talks not only about the possibility of developing AI, but builds on the premise that it is comfortably within the grasp of humans in terms of technological development, and the only factor of uncertainty is time.

machine with parts that all fit into each other, and the only task remaining is to figure out the connections. The other school of thought, the one that Hilary belongs to is convinced that there is an additional component that makes the human a conscious, sentient being capable of formulating and understanding metaphors. Whether that component is God, or something empirically defined is Hilary's constant battle with the rest of the scientific world. During a conference in Venice, Hilary in a heated outburst directed at Spike's stubborn refusal to consider her viewpoint says:

> Everything is matter. There is no science that says beauty is truth or truth beauty, but the gondolas are heaving with name tagged materialists having their mind blown at Venice. What is to be done about the sublime if you're proud to be a materialist? To save the appearance of value, no theory is too unlikely, no idea too far-out to float as long as it sounds like science – elementary particles with teeny-weeny consciousness; or a cosmos with attitude; or the life of a mind as the software of a biological computer. These are desperate measures, Spike! What does materialism remind you of? It's a faith.
>
> (Stoppard, *The Hard Problem,* 48)

One finds it easy to sympathize with Spike because the alternative seems too horrifying: discarding Hilary's opinion as garbled nonsense is easier for someone who attributes the death of a sick relative to the failure of medicine as opposed to the fanciful wielding of God's hand. Rationally speaking however, Hilary's argument doesn't solve all the mysteries in the world, it only attempts to prove that perhaps one mystery is unsolvable, indicating that scientists can abandon this one question and dedicate their resources to other pressing matters.

Hilary accepts that the question of consciousness is a valid one. That, and her ability to think outside the box is what distinguishes her not just from Spike, but Amal as well, and helps her land the job at Krohl despite him being significantly better qualified. Similar to Spike, Amal is convinced that the brain is physical, nothing more than a computing machine, and "to think otherwise would be to regress back to Plato" (24). His method of looking at the historical behavior of a system, learning from existing patterns, and using them to solve problems is endorsed by most developers of machine learning algorithms. He believes that "a chaotic system isn't *really* random, it just *looks* random", and that it is only a matter of time before the neurobiology reveals its inner dynamics (25). Because Hilary exhibits leanings towards cognitive psychology, she cannot stomach a simplistic sensory input → motor output philosophy. During her and Amal's interview at the Krohl, her boss Leo, the two men are discussing whether computers are 'thinking' while playing chess, and she jumps in, arguing that:

> **Hilary** It's not deep. If that's thinking. An adding machine on speed. A two-way switch with a memory. Why wouldn't it play chess? But when it's [my turn] to move, is the computer thoughtful or is it sitting there like a toaster? It's sitting there like a toaster.
>
> **Leo** So what would be your idea of deep?
>
> **Hilary** A computer that minds losing.

(Stoppard, *The Hard Problem*, *23)*

Hilary's main contention with AI is that they aren't programmed to feel emotion the same way humans do: to react irrationally and go off the deep end when experiencing distress. Which is why she challenges Spike to differentiate between sorrow and pain when it comes to the conscious processing of a stimulus.

MORALITY: INNATE OR ACQUIRED?

The play opens with the question of rationality in the face of a threat to one's self, taking form in an argument regarding the Prisoner's dilemma.[2] A fairly standard example in "the Ladybird book of game theory" as Hilary puts it, the Prisoner's dilemma is a game concerning the rewards associated with either betraying or cooperating with a partner in crime (4). Rationally speaking, remaining silent would be in the best interest of both participants because that would result in a minimum sentence for each. However, purely self-interested people tend to betray each other and end up with a higher sentence. Spike hotly advocates for an algorithmic zero-sum game theory type of approach, and Hilary insists that love for the accomplice can offset that approach and dismantle the entire foundation of this thought experiment.

Spike is appalled by her mentality and instantly transitions into explaining the theory that behavior and morality are simply a product of evolutionary biology. "You're not an ant or a bee," he says, referring to the group altruistic behavior exhibited by these species, and continues to berate her by providing examples of seemingly good behavior in the animal kingdom that originally stemmed from self-interest, not selflessness (5). Stoppard admits that Spike's "got a better argument, because he's on solid ground, literally … her argument is in a sense a negative corollary, it derives from a very subjective sense of what is adequate to the agony and ecstasy of human life" (Stoppard, Interview with Hytner). Hilary being anthropocentric in her ideology cannot seem to translate morality and motives developed in animals to those in humans, but Spike helps her, saying:

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[2] Formalized by Alan Tucker in 1950, the Prisoner's Dilemma is a game involving two prisoners A and B questioned separately, and offered the following deal by their prosecutors:

1. If A and B each betrays the other, each serves two years in prison
2. If A betrays B, and B remains silent, A is released and B serves three years
3. If A and B both remain silent, both of them serve one year in prison.

> **Spike** I don't see that we have much to feel superior about, as a species. Altruism is always self-interest, it just needs a little working out.
>
> **Hilary** Like you going miles out of your way to give me a lift home?
>
> **Spike** Exactly. It's a cost-benefit thing. I go miles out of my way because you might invite me in for coffee, and I throw in a tutorial to get into your –
>
> **Hilary** Pants. (Stoppard, *The Hard Problem*, 6)

Their discussion is further complicated by the introduction of the idea that genes themselves are self-serving and hence even mother love (which Hilary considers to be a virtue) is based in utility and maximizing survival of the genetic makeup. Focusing specifically on selfish versus selfless motives, her model of the "Nature-Nurture Convergence in Egoistic and Altruistic Parent-Offspring Behavior" seeks to demonstrate that Darwinian evolution cannot be the sole source of behavioral patterns (9).

It is here that Hilary questions if evolutionary biologists "left out" the element that makes us conscious because, and she has a point that resonates with Stoppard's own when she says "human DNA is seventy percent banana", and "bananas aren't thinking" (11-12). Speaking of the complexity of the human brain, she muses, "if organizing components the right way is all it takes, then a thermostat is a kiddie step towards being conscious[3]" and concludes that the idea of God cannot be that much of a stretch of the imagination (12). For a sufficiently skeptical member of the audience, this is a good time to scoff at Hilary's unconvincing logic, but she later clarifies that her faith is less in "someone who created the world in six days and then had a rest," but in an entity that can perhaps explain the disjunction between a grunting chimp ancestor and a human

[3] This strongly resonates with Thomasina's musings in *Arcadia* about what is wrong with the prevailing design of the universe, especially where she calls classical geometry the "shapes of manufacture" (Stoppard, 55).

using words like "hypothesis" (50,10). Advocating yet again for the argument for evo-bio and the arrangement of neurons, Spike says:

> **Spike** But it's pathetic to rely on a supreme being to underwrite what you call your values. Why are you afraid of making your own?
>
> **Hilary** You don't claim to make your own. What's the difference between a supreme being and a being programmed by your biology?
>
> **Spike** Freedom. I can override the programming.
>
> **Hilary** Who can? Who's the 'you' outside your brain? *Where?*
>
> *(*Stoppard, *The Hard Problem*, 48*)*

Here Spike slips into murky waters because Hilary is approaching the question of free will that was also briefly touched upon in *Arcadia*. The conversation between Hilary and Spike is essentially the difference between a vehement atheist and an agnostic, and it leaves an unmistakable trace of a Richard Dawkins[4] convention wherein a dismissive attitude towards competing theories seems rather reductionist and less compelling than a healthy openness to possibility.

The debate of morality and consciousness as being products of evolution or something else is one that has plagued scientists for decades now. Stoppard cites the scientists Thomas

[4] The first chapter of Richard Dawkins' book *The God Delusion* tries to differentiate Einstein or Hawking's pantheism from belief in the supernatural by terming it "sexed up atheism" and argues that God almost certainly does not exist. However, in the interview Stoppard mentions that in a later book *Religion without God*, Dawkins provides a gem of a quote that is extremely relevant to this play. He argues that "it is our living, evolved conception of virtue which has defined our deities, and therefore, by ineluctable logic, our values must have preceded the idea of God" (Stoppard, Interview with Hytner).

Nagel[5] and John Searle[6] in his acknowledgements for this play, and Hilary is emblematic of their philosophies, questioning "how do we get from the physics to the semantics? From the noise to meaning" (Searle, Interview 2014). She even experiences slander and criticism similar to Nagel with her publication "Is God the Last Man Standing" wherein she uses equations that show the disparity between the amount of time required for evolution by chance mutations and geological time, thereby implying that "every theory of consciousness has the same degree of demonstrability as divine intervention" (54). Although Stoppard doesn't explicitly launch into a detailed exploration of these various theories, he does have Hilary consult Ursula, another employee at Krohl about the legitimacy of the prevalent theories. It is worthwhile to delve into a few of them because it serves to emphasize her rigor as a scientist even though she seems somewhat of a creationist at times.

ORIGINS OF THE CONSCIOUS MIND

Hilary raises the issue of Gödel's incompleteness theorem,[7] which states that within any consistent algebraic system, there exist statements that neither be proven nor be disproven. Douglas Hofstadter wrote a seven-hundred-page book to explicate the complexity of this theorem, and relate it to human existence in general, and presumably for reasons of minimalism Stoppard left out a discussion on whether the brain as a consistent or inconsistent system. Were it possible to prove that the brain swayed a certain way, it would be easy to conclude whether it is a computing machine that Amal has resolutely believed it to be, or if it requires something extra.

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[5] Thomas Nagel is an American philosopher who, in *Mind and Cosmos* argues that materialism cannot possibly account for consciousness and the mind-body problem. He was hailed by Creationists and his book was cause for immense debate when it got published.

[6] Stoppard mentions John Searle in his interview with Hytner, saying that "[Searle] found that the adherence of the computational mind was more fervent than the people positing something from religious doctrines," which is a continuous thread in this play.

[7] In *Gödel Escher Bach*, the theorem is explained with a helpful analogy: "for each record player, there is a record it cannot play" (Contractostipunctus, Hofstadter).

The ambiguity of this issue is crucial for the possibility that Hilary raises, namely the one of quantum consciousness. Roger Penrose along with Stuart Hameroff[8] thinks that developments in neurobiology indicate that while administering anesthesia, quantum mechanical forces are at play and that they induce chemicals to alter their structure. If that is the case, free will obviously is biochemically impossible, but quantum processes could be the hidden element that makes one human different from another, and the theory also successfully discards a deterministic and fatalistic outlook of explaining the mind.

Because she pitches the idea of God, Hilary loses credibility among the scientific community to some degree and causes her boss Leo to reprimand her, but it almost validates her point about materialism seeming dangerously like a faith. "The reason it's *hard*, you pig's arse, is that mind-body is the problem," Leo yells, and it seems to resonate with Spike's assertion that he would "get antsy if there [weren't] a new journal to look at every day" (55, 50). In short, the scientists are so accustomed to keep looking for answers to problems that a simple, straightforward explanation like God would make them feel helpless and unable to contribute to society, and take away from the reverence that the empiricism of their profession is treated with. It is fascinating to note how closely this issue relates to the one about altruism that Hilary is jointly exploring. The attitudes expressed by Leo and Spike are the embodiment of the selfish motives of successful members of the human species to further their kind to ensure their own survival and that of the scientific community.

[8] Together, Penrose and Hameroff produced the Orch-OR (Orchestrated Objective Reduction) theory which makes a case for quantum consciousness. Stoppard also corroborates this theory in his interview.

ALTRUISM: IN THE LAB AND AT THE TRADING DESK

The other angle that Stoppard chooses to employ to further explore the issue of altruism is the one that serves to tie the pieces of the play together. In that sense, the closest he gets to developing a theatrical analogue to reflect a scientific problem is the financial market which consists entirely of egoistical transactions carried out by people motivated by self-interest. By introducing a setting such as this, Stoppard puts pressure on both sides of the anthropocentric argument. Hilary is rooting for the uniqueness of consciousness in humans to argue for the existence of a moral compass, whereas Spike is purely Darwinian and doesn't concede to a fundamental difference between species. However, the ecosystem of traders is akin to a pack of wolves with several alphas who somehow coexist peaceably: an unrealistic situation which undermines Spike's ideology. At the same time, like Amal says, to imagine traders as altruists is out of the question because they resemble "African polar bears" in their intransigence to forego their own fitness (65). So, within the ecosystem of the financial market, people exhibit group behavior while being fiercely self-serving, which is exactly what Hilary is trying to study in her egoism-altruism paradigm.

Along with the genetic aspects of behavior, Hilary suspects social and environmental factors that contribute to decision making; Spike on the other hand is convinced that human reactions to situations are purely biochemical. He publishes a paper on how hormonal responses can be accurate predictors of market behavior. In general, people were thought to roughly be categorized as having risk seeking or risk averse personalities. However, his study shows that regardless of that affiliation, in 'bull' market conditions, traders have high levels of testosterone and make high risk, aggressive gambles, whereas in 'bear' market conditions people regularly express high levels of the stress hormone cortisol, which makes them more conservative in their

transactions. This is a very "sexy" result, and it gets Spike hired by Krohl, because the findings imply a "monetization of the hormonal state of the trading desk" (56-57). However, a step towards a physiological basis of AI is a step away from a psychological one, and given the present conditions, Spike's success happens to be at the expense of the future of Hilary's department.

While we witness Spike going behind Hilary's back to improve his status and perhaps adversely affect hers, we also see Bo stepping down from her job as a quant at KCM to work under Hilary because the money wasn't *good.* Bo's conscience couldn't handle the idea that her job involved "gaming the market to make more money for people with money" and so she quit, endangering her evolutionary fitness by settling for a smaller paycheck (42). Bo's desire to "do good with math" seems to make her an ideal candidate for studying altruism (42). Similar to Milgram's famous Stanford prison experiment which used increasingly intense electric shocks on an actor to test a subject's submission to authority, Batson[9] designed an experiment where the subjects were asked if they wanted to switch spots with the individual undergoing supposed torture as a measure of true altruism. He suspected that empathy played a role in the extent to which volunteers would give up their own comfort for somebody else. Like the original experiment (not mentioned in the play) Hilary was simulating this phenomenon by introducing a random suggestibility for empathy. Instead, Bo shrewdly pointed out that using their personal

[9] Batson's experiment was a variation of the Milgram study. It was designed not to study people's adherence to authority, but their willingness to help a person being tortured. The 'subject' Elaine (who is actually an actor), is reacting to increasingly high intensities of an electric shock. Based on a completely irrelevant questionnaire, the subjects of the psychological experiment are randomly assigned to being high or low on the scale of empathy, and are informed of their status. They are then shown the footage of Elaine being tortured and asked if they're willing to trade spots. The purpose of the experiment is to test for altruism (reduced personal fitness) with a suggestibility for empathy. There are further variations where the test subjects are offered an easy or difficult escape from the situation, and that is also a variable that Batson examined.

information to *induce* empathy would be better measure than an impersonal suggestion to the subjects that they tested high on empathy.

Although Hilary does adopt Bo's suggestion of using the subjects' personal information, she informs Bo of the perils of compensating for outliers that can potentially skew the results of a hypothesis, warning her "that's a sin" (40). This is a chilling foreshadowing of a few scenes later where it turns out that Bo did intentionally exclude outliers from her findings. It is important to note the continual emphasis that Stoppard places on the scientific method and the possible repercussions that accompany the wrongful drawing of conclusions or tampering of data. Just like Bernard (in *Arcadia*) who ignores glaring contradictions to his Byron theory, Bo willfully excludes data that doesn't fit with her desired conclusion[10]. Right around the time of Hilary and Bo's discussion about ethics, Jerry's daughter Cathy walks in on Elaine (the test subject) being filmed shrieking with increasing distress in response to shocks as part of the experiment. Without being provided any context, Cathy expresses concern at the sight she beholds. Although she doesn't offer to take her place instead, it is interesting to note that she tests high on empathy[11].

Jerry Krohl's influencing almost an entire school to participate in the experiment ensures a well distributed, large sample size, and some promising results lead to a paper jointly published by Hilary and Bo titled "Ultimate Goods," which demonstrates that people are born altruists by nature, but societal influence makes them progressively egotistical. This is in direct opposition to the selfish gene hypothesis "that we start of nasty and learn to be nice" (63). In the conversation

[10] This practice of choosing to divulge only favorable results is commonly known as "cherry-picking" in the scientific community

[11] Especially so because Cathy is the Catherine that Hilary gave up for adoption, and her being highly altruistic in a household run by a hedge fund trader provides some bearing to Hilary's research on parent-offspring behavioral tendencies.

related to the experiment, Bo questions why the motive for good behavior matters, to which Hilary responds that “it might matter if people who are out for themselves think they’re justified by biology”, echoing Stoppard who doesn’t like the idea of “marking your own homework” (Stoppard, *The Hard Problem,* 39; Interviews with Hytner). This is an extremely destabilizing perspective for someone like Spike (or even Amal) who does really think that selfishness is inherent, and his lack of stability is reflected in his inebriated state at the mini celebration at Hilary’s place.

Spike’s sneering comment about the neat linear relationship giving off “a distinct whiff of week-old fish” does end up being true (64). The reason behind Bo tampering the evidence however, is more interesting than the act itself. Her fault is that she is in love with Hilary and wants to please her, which makes her motives selfish. Of course, it raises questions about the legitimacy of Bo’s earlier work, the mathematics upon which Hilary based her whole argument about divine intervention and is the foundation for changing her career path, but that is an issue Stoppard doesn’t address.

Coming back to the question of motivated behavior, following Bo’s unscrupulousness, Hilary makes an addendum to the publication, resigns her position at the Krohl, and goes on to study philosophy. Her reasons for doing so are to ensure Bo’s evolutionary survival and fitness, seeing as she is a beginner and “the best mathematician in the house” which is beneficial to the Krohl, making Hilary’s motives altruistic in nature (70). Hilary essentially enacts her version of the Prisoner’s Dilemma, which serves as her first concrete triumph over Spike. However, as Jerry points out, her leaving the Krohl by “doing [her] best to bring Leo’s department around his ears sounds more like egoism” (73).

Unlike the concepts that the characters explore, the narrative itself seems to fall too neatly into place: Julia Chamberlain,[12] a classmate from Hilary's high school, happens to be teaching pilates at Krohl. Amal doesn't get the job he interviewed for but became a quant at Krohl Capital where he dated Bo and referred her to the Brain Sciences Institute, and she happened to work in Hilary's department. Spike too met Jerry on a boat and landed a job at Krohl. The biggest kicker undoubtedly is Hilary's daughter being adopted by the Jerry Krohl himself. Stoppard resolves this by having Jerry explain to Cathy that a coincidence is "if two things which you don't normally expect to happen at the same time, happen at the same time…" and quickly amends the definition to say that there's reasons why the events happen, "you just didn't have the information" (27). Coincidences abound in this play, and some of them have probabilities low enough to qualify as miracles, and yet Stoppard warns against leaping to that conclusion as Hilary is prone to do.

Amal lapses into a diatribe on his position at KCM, saying that "the models [for predictive risk] can be proved mathematically to crash about once in the lifetime of the universe. But every now and then, the market's behavior becomes irrational, as though it's gone mad, or fallen in love. It doesn't compute. It's only computers compute," and this type of behavior is caused due thousands of humans simultaneously behaving irrationally to make an unlikely event happen, we just don't *have* all the information (68). I think Stoppard is ultimately trying to say that he cannot back up Amal about humans easily being able to program their own minds, but he also doesn't entirely believe Hilary's explanation about God, because there is an infinitude of information that we don't yet possess. He doesn't think he can possibly have a definite answer,

[12] Stoppard reveals a fun fact about his plays: each of them contains his secretary Chamberlain's name, saying that he put it in there to "wake her up" as she typed out his scripts.

"but that great thing about the situation is that … honestly nobody knows. Nobody has the faintest idea. And perhaps it's a matter of time, and one day perhaps we'll understand how conscious emerges from hundred billion neurons in the skull… or maybe we'll never know because our particular brand of logic doesn't fit well with the deep explanation of consciousness" (Stoppard, Interview with Hytner).

EVOLUTION AND COLLATERAL DAMAGE

Jerry is aware of the questionable nature of his motives, and is completely unfazed by it. In fact, he is so hungry for a lucrative deal that he will go to any lengths to secure one. Amal, who has a degree in mathematics and biophysics is not trained to be a businessman, and despite enjoying the monetary benefits of his new job, he cannot knowingly take advantage of gullible investors. Due to this ideology, he advised a client to make a wise deal that was deemed financially pessimistic and lost KGB a lot of money. After causing Amal to nearly faint, Jerry makes him sign a contract forcing him to "share [his] limp-dick, short the market wisdom with nobody except [his] advisor – with a sign around [his] neck saying 'Arsehole'", which begs the question: who is the real 'Arsehole'? (33) Amal was absolutely correct in guessing that because the "market is acting stupid, and the models are out of whack," the market was in danger of getting shorted (33). Stoppard was anticipating the collapse of the housing market, and even though he wanted to prevent it, Amal was contractually bound to keep his mouth shut while "a lot of people were selling fire insurance on a house that was burning" (74). Subsequently, the question that leaps to mind is, who is the bigger miscreant: Bo or Jerry? Which further raises questions as to whether the punishment meted out to her (or Hilary) is justified while Jerry simply got to amass a greater wealth. Much like the arguments between Spike and Hilary that Stoppard leaves on a

caesura, this is an open-ended question with respect to morality and survival that the audience is expected to reflect on.

Even as she spends her time studying innate versus acquired morality, Hilary is never free from the clutches of her own conscience regarding her unknown daughter. In a way, Hilary is the product of choices that Elizabeth Hapgood didn't make: both women live with regret, but Hilary's sorrow at giving up her child far surpasses Hapgood's for choosing the professional over the personal. The prayers that Hilary says every night are for Catherine's well-being.

On Cathy's sudden appearance in her office, Hilary receives a sudden jolt as she is reminded of her own daughter, and feels excruciatingly guilty about having "gone weeks without thinking of Catherine. Months. [She'd] been letting her go, as though [she'd] swapped her for a doctorate" (44). Hilary gets misty eyed every time she hears firecrackers, and the main reason for her anguish is the helplessness she feels in the situation. Stoppard drops several hints during the course of the narrative – such as Cathy's exaggerated boredom slump that was obviously inherited – to indicate her relationship to Hilary. Hilary does entertain the sneaking suspicion that Cathy could be the same as her thirteen-year-old Catherine, but her suspicions would never have been confirmed unless her paper had caught Jerry's eye and seemed inaccurate.

Leo *(beat)* Jerry said the paper was wrong.

Hilary He read it?

Leo It pissed him off that his daughter's group scored low on nice and high on not so nice. He said Cathy was the nicest person in his family.

Hilary You'd think Jerry would approve of a bit of egoism in his genes.

Leo His genes don't come into it – Cathy's adopted.

(Stoppard, *The Hard Problem*, 71)

This news comes as a massive relief for Hilary, and egoistic motives or not, Hilary's entire reason for studying altruism and nature-nature convergence is an attempt to dispel the uncertainty that surrounds the character of her daughter and the treatment she most receives from her foster parents. The play reaches a poignantly dramatic denouement as Jerry hands Cathy's security pass to her biological mother before she quits the Krohl. In a way, although the scientific malpractice marked the end of Hilary's career as a psychologist, it was a liberating factor that to her felt "like the first day of spring" and led to her wholeheartedly pursuing the hard problem of consciousness (75).

CONCLUSION

Stoppard could not have chosen more unique locations than an old aristocratic country home, the British secret service, and a neuroscience lab as the setting for his three science plays. The central tenets of each are radically different, and yet common themes weave their way through the labyrinths of abstract scientific concepts and complicated human relationships that are depicted in them. The more superficial ones would be those that compare features of each of the characters, such as Hilary and Hapgood both being mothers whose lives are inextricably tied to that of their child. In the same vein, Valentine explaining esoteric concepts in modern math and physics is similar to the Kerner figure in *Hapgood* filtering all of quantum mechanics through spy analogy.

However, it seems that Stoppard revisits bigger questions that he either left unanswered or warranted more stage time. In her 2013 essay, Kelly mentions that Stoppard's "later work has not only extended his previous preoccupation with memory, uncertainty and ethics, but also deepened the sense of human consequence growing from ethical conflict and intellectual doubt" and *The Hard Problem* is an embodiment of this extension ("Introduction: Tom Stoppard in Transformation",10). Stoppard mentions that his preoccupation with morality and altruism stretches back to at least as far *Jumpers* wherein "the main character [George Moore] was a moral philosopher" wrestling with himself on the issue 'Is God?' (Stoppard, Interview with Hytner). Meanwhile, Moore's wife is in the other room cradling the body of a dead gymnast. In addition to the distress caused by the death, she is extremely harrowed by NASA's (in this case a British agency's) moon landing, and is depicted as watching footage of an astronaut who left his

colleague to die[1]. The similarity to *The Hard Problem* is uncanny, although the newer play engages with other aspects of metaphysics and human behavior in greater detail.

Arcadia features an engagement with the ethics of conducting research, and considered alongside *The Hard Problem*, Bernard, Hannah, Jerry, and Bo cover all the permutations of things that could possibly go awry during the course of an experiment. Hannah initially formulates the wrong hypothesis, as does Bernard, but he is blind to contradictory evidence, while Jerry and Bo both rig their experiments to get the results they want. It is highly interesting to note that the motives for each of them differ. *Hapgood* on the other hand explores ethical behavior outside the sterile situation of a lab, with almost all the characters indulging in selfish behavior to achieve their personal ends. In fact, their behavior serves to undermine Hilary's conviction of goodness because although she is possibly the only person who acts remotely selflessly and resigns from her job, the characters in *Hapgood* establish that real life is different from simulated experiments.

Of course, this conclusion clashes horribly with Kerner's perspective on life because his method for validating behavior resides in the subatomic world. However, his outlook has ample backing in the message of non-linearity that *Arcadia* advocates for, and Hilary embodies in her openness to possibilities. Most importantly, all three plays value the concept of uncertainty and the belief that determinism isn't always an option. Mathematical models fail because real data is noisy, "like a piano in the next room, it's playing your song but unfortunately it's out of whack," and Amal echoes Valentine when he says "every now and then, the market's behavior becomes irrational, as though it's gone mad, or fallen in love. It doesn't compute" (Stoppard, *Arcadia* 66,

[1] This is an exhibition of self-interested behavior. Interestingly Stoppard inverted events that took place during a south pole expedition wherein explorer Scott "sacrificed his life to save the other members of his team" i.e. an act of pure altruism (Kelly, *Tom Stoppard and the Craft of Comedy 98*).

The Hard Problem 68*).* Attempting to write an algorithm to describe the ordinary *or* the extraordinary is a noble endeavor: one which scientists, philosophers, and artists have been pursuing in one way or another for centuries. Stoppard houses an ambivalence as to whether it can be done. Regardless, there is one issue on which he holds his ground: obstinately and narrow-mindedly clutching on to a belief does not lead to the answer.

Writing about *Hapgood,* Katherine Kelly describes Kerner as taking "a scientific approach to the art of spying and an artful approach to science" (*Tom Stoppard and the Craft of Comedy*,152). Just as Stoppard writes himself into the character of Henry in *The Real Thing*,[2] he imbues his technique of reconstructing science in an artistic context into his character of Kerner. Kerner has a charming manner of relating words to quantum physics, and in turn physics to human behavior. Stoppard operates with the same precision of a scientist, breaking down concepts into threads that can be traversed, only to eventually tie them up in a complex web of interaction that presents human behavior in a different light. An artist with a holistic grasp of science and its relatability to the world, Stoppard exploits his very assets to contribute uniquely to the thespian world. His ability to weave magic is heightened by the presence of a few loose strands of ideas, because he picks them up at a later point and proceeds to seamlessly explore hitherto unconceived premises.

Uncertainty *is* the baggage accompanying any scientific endeavor, and Stoppard introduces the concept in the first of the three plays, takes advantage of its analogous scientific principle in the second, and has the third play completely revolve around it, as he relates uncertainty to human behavior in increasing amounts. Through his characters who either blunder

[2] Henry is a playwright who weaves magic with words and treats dialogue like a well-designed cricket bat, but treats love and fidelity with cynicism and perplexity. Stoppard wrote the play shortly after his divorce, and there are several autobiographical elements in the play concerning vulnerability to love.

through, or embrace any setbacks to their progress, Stoppard exhibits that the only way forward is through rigorous scientific practices of asking questions and interpreting answers. His outlook on life is mirrored in his methodology, and this is what lends Stoppard his unique flavor as a genius.

In that respect, Stoppard closely resembles Douglas Hofstadter[3] who distils the art from mathematics and conversely draws attention to the intricate mathematics within art. Even though it is the third play that introduces the incompleteness theorem proposed by Kurt Gödel, the recurrence relations, self-reference and self-similarity that make up the structure of *Arcadia* embodies his mathematics. The word usage and doubling employed in *Hapgood* undoubtedly mirrors M.C Escher's dizzying and brain numbing illustrations and optical illusions wherein a single element represents more than one thing.[4] A different kind of artist, J.S. Bach was not only famous for his improvised composition of utterly complex fugues but also for his spirituality and engagement with the metaphysical.[5] He serves as the perfect analogy for *The Hard Problem* where musical notes building up towards a symphony parallel neural architecture leading to the formation of a thought, and the sublimity of musical experience parallels the magic of linguistic metaphor.

In *Arcadia, Hapgood*, and *The Hard Problem,* questions about the human mind, morals, and behavior get compactly condensed, weaving their way through the forever growing mesh of scientific theory, making significant headway in shedding light on people and their relation to the natural world. With an "extraterritorial perfection" of words and a delicate execution of

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[3] Author of *Gödel, Escher, Bach an Eternal Golden Braid,* Hofstadter uses a Lewis Carroll-ian approach to explicating how the underlying concepts of the works of the mathematician (Gödel), artist (Escher) and composer (Bach) are structurally similar and interconnected, and how the concept of infinity combined with tropes endorsed by each of these three pillars build a foundation to the contemporary world.

[4] Figure 3 M.C. Escher's Sky and Water I, Birds and Fish doubled by a "trick of the light."

[5] Wilfred Meller's *Bach and the Dance of God* is a thorough, if somewhat inaccurate, interpretation of Bach's music in religious, philosophical and psychological terms.

speculative dialectic, Tom Stoppard writes three brilliant plays, which together form an Eternal Golden Braid (James, 70).

ILLUSTRATIONS

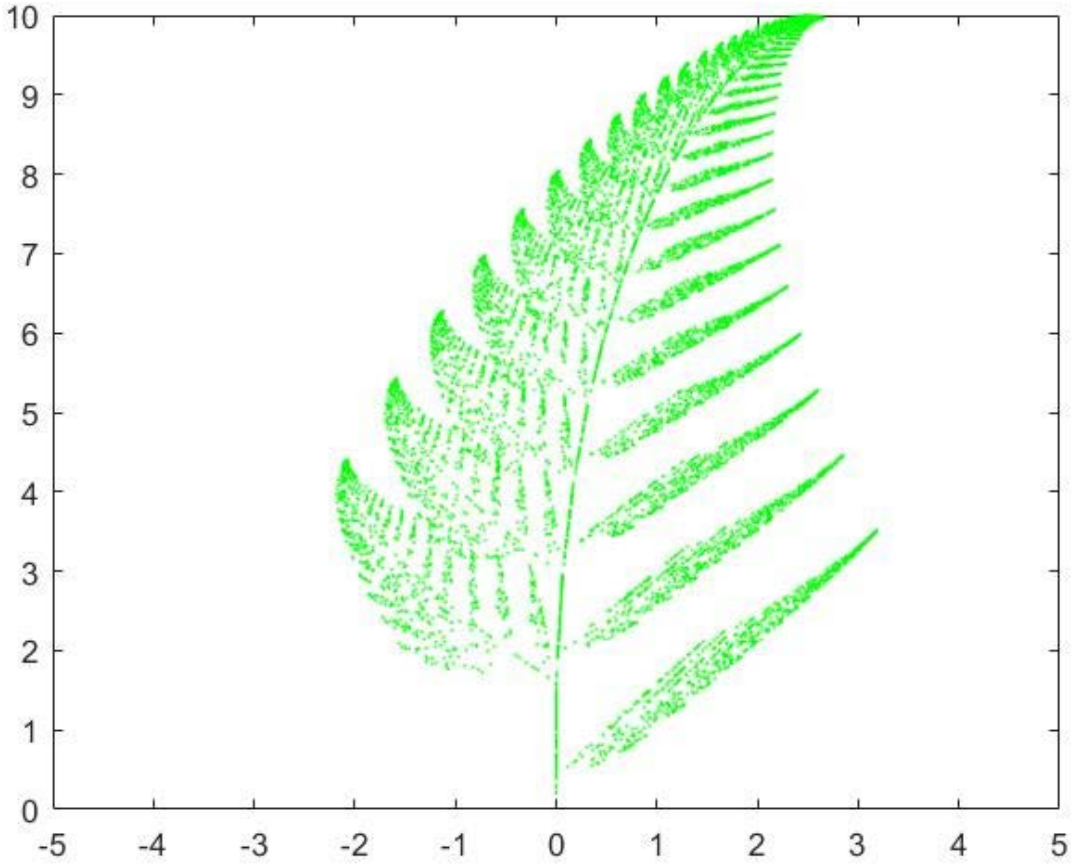

Figure 1 An algorithm iterated ten thousand times to produce a self-similar leaf

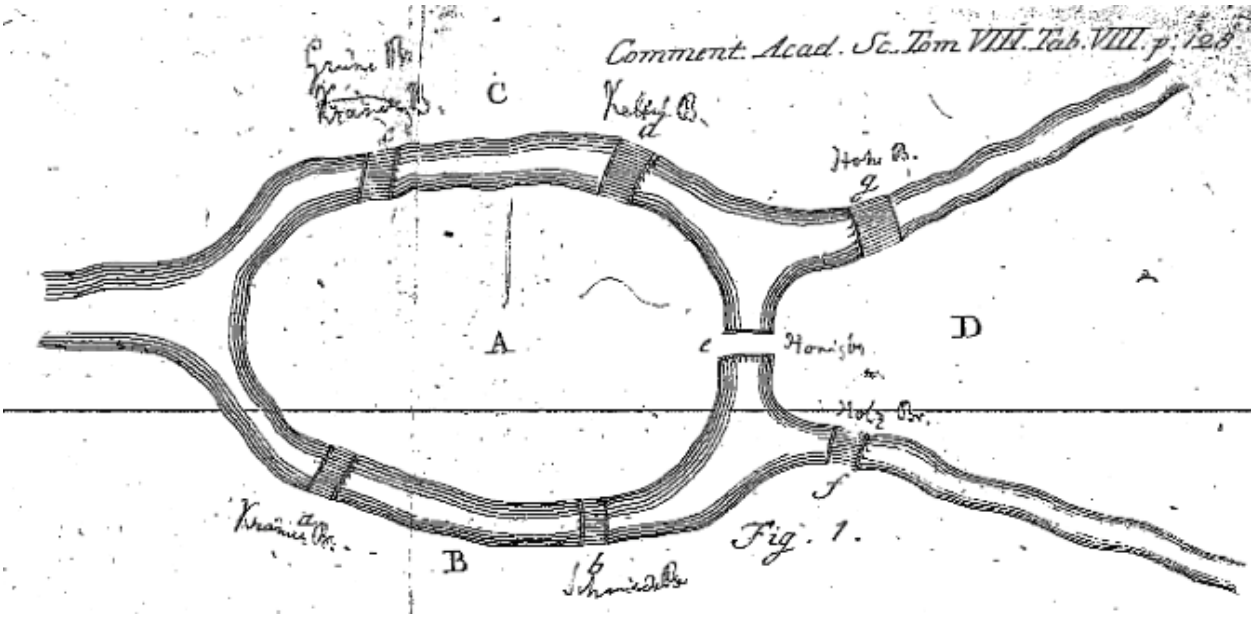

Figure 2 The Seven Bridges of Kongsberg, solved by Leonard Euler. Kerner says: "Imagine nutcrackers with one bridge across the handles and one across the hinge and four bridges on to the island which would be a walnut if you were cracking walnuts"

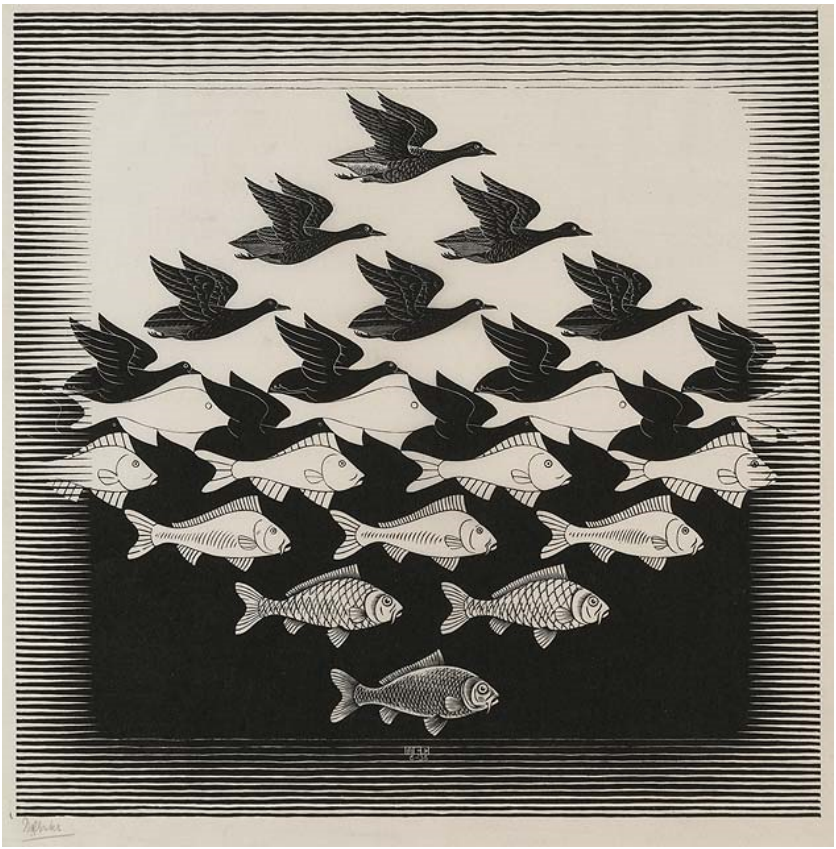

Figure 3 M.C. Escher's Sky and Water I, Birds and Fish doubled by a "trick of the light"

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